Final Report at Georgia Tech:

Water Cycle between Ocean and Land and its Influence on Climate Variability over the South American-Atlantic Regions as Determined by QuikSCAT/SeaWinds Observations

Ocean Vector Winds Science Team,
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1. INTRODUCTION

This project is to apply QuikSCAT and SeaWinds data to the hydrological coupling between land and ocean. The objectives are to:

1) Examine the influence of South American rainfall on the interannual variations over the tropical Atlantic during boreal spring, particularly on the onset of Atlantic Nino and inter-hemispheric mode of SST anomalies in that region.
2) Determine the influence of oceanic moisture transport on the South American monsoon onset, demise, and rainfall pattern, and their interannual variations using the QuikSCAT moisture transport product; explore use of this product for the prediction of wet season onset and demise over South America; and evaluate the realism of the moisture transport derived from reanalysis products;
3) Use high resolution σ_o and in situ observations over the Amazon to identify the signals related to canopy wetness, to characterize its occurrence and spatial pattern, and to explore joint use of tandem QuikSCAT/SeaWinds σ_o and MODIS to improve the observations of vegetation in cloudy and rainy conditions and its seasonality over the Amazon;

2. ACTIVITIES

1) Analyze the influence of Amazonian convection on Atlantic ITCZ through Kelvin waves

Using outgoing longwave radiation (OLR) and Tropical Rainfall Measuring Mission (TRMM) daily rain-rate data, we have detected systematic changes in intensity and location of the Atlantic intertropical convergence zone (ITCZ) along the equator during boreal spring. It is found that the changes in convection over the tropical Atlantic may be induced by deep convection in equatorial South America. Lagged regression analyses demonstrate that the anomalies of convection developed over the land propagate eastward across the Atlantic and then into Africa. The eastward propagating disturbances appear to be convectively coupled Kelvin waves with a period of 6–7.5 days and a phase speed of around 15 m s^{-1}. These waves modulate the intensity and location of the convection in the tropical Atlantic and result in a zonal variation of the Atlantic ITCZ on synoptic time scales. The convectively coupled Kelvin wave has substantial signals in both the lower and upper troposphere. Both a reanalysis dataset and the QuikSCAT ocean surface wind are used to characterize the Kelvin wave. It suggests that synoptic-scale variation of the Atlantic ITCZ may be linked to precipitation anomalies in South America through the convectively coupled Kelvin wave. The results imply that the changes of Amazon convection could contribute to the large variability of the tropical Atlantic ITCZ observed during boreal spring. Above results have been published in Journal of Climate (Wang and Fu 2007).

2) Use of QuikScat oceans surface winds for the prediction of the LLJs in South America: This work has been published at the International Journal of Remote Sensing – A special issue for PORSEC 2008.

3) Analyze the influence of Amazonian rainfall on tropical Atlantic Nino.

Using TRMM daily rain-rate dada, the QuikSCAT ocean surface wind and PIRATA buoy data, we have found that convection developed over the Amazonia appears to propagate eastward across the Atlantic and then into Africa. Such changes modulate the intensity and location of the convection within the Atlantic ITCZ and result in a zonal oscillation of the ITCZ between the west and east equatorial Atlantic Ocean. Such convectively coupled Kelvin wave is particularly strong during boreal spring and dominates the synoptic variations of the lower and upper troposphere winds. We further find that the interannual changes of these convective coupled Kelvin waves have an important influence on trigging the onset of Atlantic Ninos. In particular, later northward draw of the South American rainfall in boreal spring lead to stronger Kelvin wave activities and stronger westerly wind anomalies in the western and central equatorial Atlantic. The latter changes the slope of the thermocline of the equatorial Atlantic Ocean and induces sea surface temperature anomalies in the eastern Atlantic, consequently the onset of the Atlantic Nino during earlier boreal summer.

We are preparing a paper based on above results.

4) Collaboration with other team member: Prof. Han's group at the University of Colorado, Boulder:

We have provided inputs of the wind anomalies associated with convective coupled Kevin waves originated from Amazon to Prof. Han to force HYCOM ocean models, to test the impact of these atmospheric waves on SST and thermocline depth in the tropical Atlantic ocean. One paper has appeared in J. of Physical Oceanography (Han et al. 2008), another paper is in preparation.

3. PUBLICATIONS FROM THE PROJECT

1) Wang, H., and R. Fu**,** 2007: The influence of Amazon rainfall on the Atlantic ITCZ through convectively coupled Kelvin waves, *J. Climate,* 1188-1201.

2) Wang, H, **R. Fu**, J. K. Schemm, W. T. Liu, W. Q. Tang, 2007: Prediction of South American low-level jet using QuikSCAT ocean surface wind, the ***International Journal of Remote Sensing***, A Special Issue for PORSEC. In press.

3) Han, W.H., P. J. Webster, J. L. Lin, W. T. Liu, R. Fu, 2007: Dynamics of intraseasonal sea level and thermocline variability in the equatorial Atlantic during 2002-2003. *J. Phys. Oceanography*, 38, 945-967.

4) Fu, R. and H. Wang: Observed Influence of Amazon rainfall on the Atlantic ITCZ and Atlantic Niño, *in preparation*.